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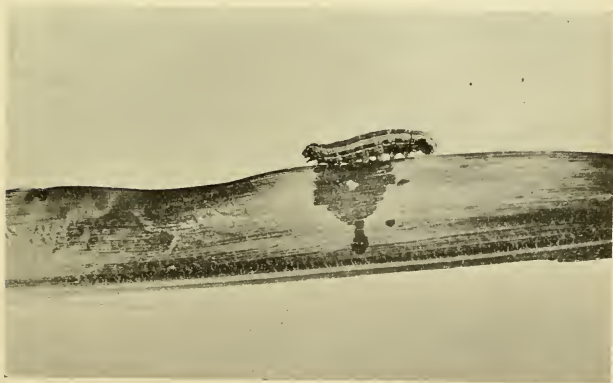
NEW HAMPSHIRE COLLEGE
AGRICULTURAL EXPERIMENT STATION



A Thousand Army Worm Moths

THE ARMY WORM

BY CLARENCE M. WEED



THE ARMY WORM IN NEW HAMPSHIRE IN 1770

“In the summer of 1770 this whole section was visited by an extraordinary calamity, such a one as the country never experienced before or since. It was an army of worms which extended from Lancaster, N. H., to Northfield in Massachusetts. They began to appear the latter part of July, 1770, and continued their ravages until September. The inhabitants denominated them the “Northern Army,” as they seemed to advance from the north or northwest and to pass east and south. They were altogether too innumerable for multitude. Dr. Bouton of Thetford, Vt., told me that he had seen whole pastures so covered that he could not put down his finger on a single spot without placing it upon a worm. He said he had seen more than ten bushels in a heap. They were unlike anything which the present generation have ever seen! There was a stripe upon the back like black velvet, on either side a stripe from end to end, and the rest of the body was brown. . . . They appeared to be in great haste, except when they halted to devour their food. They filled the houses of the inhabitants and entered their kneading troughs, as did the frogs in Egypt. They would go up the side of a house and over it in such a compact column that nothing of the boards or shingles could be seen. They did not take hold of the pumpkin vine, pease, potatoes or flax; but wheat and corn disappeared before them as if by magic. They would climb up stalks of wheat, eat off the stalk just below the head, and almost as soon as the head had fallen upon the ground it was devoured.”—*The Reverend Grant Powers, Historical Sketches of the Coös Country, Haverhill, N. H., 1841.*

THE ARMY WORM IN NEW HAMPSHIRE

BY CLARENCE M. WEED

Early in July, the present season, complaints began to reach the Experiment Station of the injuries inflicted by the Army Worm* upon grain and grass fields. Whenever specimens were submitted, they proved to be the true Army Worm. In addition to the accounts received by us direct from correspondents, there were many notices in the daily papers, showing the presence of the pest in various parts of the state. The data at hand indicates that there were local outbreaks, here and there, over a large part of New Hampshire, especially in the southern half and the region bordering the Connecticut river.

Serious injury, especially in barley fields, was done during July; and again in September, when another brood of worms had developed, especial damage was reported to be done in fields of Hungarian grass.

As soon as the first outbreak was reported, I visited the infested fields, studying the worms at work, and bringing specimens to the station, where they were placed in breeding cages to determine their life-histories. The results of these and subsequent studies, as well as a summary of our knowledge of the insect in general, are embodied in this bulletin.

PREVIOUS OUTBREAKS OF THE ARMY WORM

The army worm is believed to have occurred in New England as long ago as 1743, a year when, according to early records, there appeared "millions of devouring worms in armies, threatening to cut off every green thing." That the pest was present in New Hampshire in 1770, is shown by the quotation on the second page of this bulletin. There is little evidence of its again occurring in New England in great abundance until 1861, when it was very destructive, as it was also

* *Leucania unipuncta*.

in 1875. The last serious and widespread outbreak in New England appears to have been that of 1880. The present season the injury by army worms has been very general, not only throughout New England, but in many other eastern states.

The Army Worm is generally destructive in seasons following years of unusual drouth. It is seldom injurious in a given

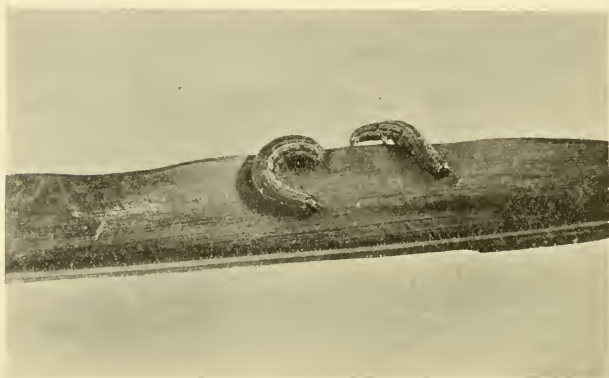


FIG. 3. Two Army Worms. From photograph by New York Experiment Station.

locality for two successive summers, but it is worth while to burn over—in autumn, winter, or spring—fields where it may be present.

THE LIFE OF THE ARMY WORM

The story of the life of the individual army worm may be briefly told. On some summer night there appears in the meadow a good-sized light brown moth. Flying about she finds a cluster of strong-growing grass. Into the folded leaves of one or more of these she pushes a number of small whitish eggs, gluing them in rows of a dozen or more. A week or ten days later each egg hatches into a minute, whitish worm, that nibbles at the grass blades at night, and in the daytime hides beneath the grass from the rays of the sweltering sun.

It grows rapidly in size. At the end of a week it moults or casts its skin, a process in which the old skin splits open along the back and the worm crawls out, clothed in a new skin that had developed beneath the old one. Again it feeds as before, its voracity increasing with its size. This moulting is repeated four or five times during the month after the worms hatch, so that by the end of this period the insect is an inch and a half long, and has the familiar markings of the full-grown army worm.

The instinct of the worm now teaches it to seek more secure shelter for the helpless stage upon which it is about to enter. It burrows into the soil an inch or less and wriggles about in the earth until it produces a hollow cell. In this it casts its skin again and becomes a pupa—the third stage of its existence. When the worms are very abundant, many of them do not go into the ground but change to pupæ beneath whatever shelter may be at hand. About a fortnight later, another change takes place, and the fully-developed moth emerges from the pupa, thus completing the round of the insect's life. The moths fly towards dusk and at night, and by means of their long tongues, coiled up when not in use, they suck the nectar of various flowers.

The moths sometimes seem attracted by buildings. I have been told of their swarming toward the close of cloudy afternoons about barns and outbuildings; and early in August, this year, they were trapped by thousands in the projecting porch of Thompson Hall. We killed one thousand of these moths, placed them in a little heap, and photographed them. The photograph is reproduced on the title page of this bulletin. It represents the moths about one-half natural size, and seems a small pile, but had the moths not been killed there might have developed from them in September nearly half a million army worms.

THE ARMY HABIT

During ordinary years the army worm is present in most of the regions where its outbreaks occur, individual worms feeding here and there in meadows and pasture lands, but the number is not sufficient to attract notice. At such times their

habits of life are very similar to those of the common cutworms to which, indeed, the army worms are closely related. It is only when these insects become so excessively numerous that they exhaust the food supply of the field in which they develop, that the "army" habit is assumed. Then, however, they are forced to seek new quarters for food, and as their only mode of progress is by crawling along the ground, they move in solid

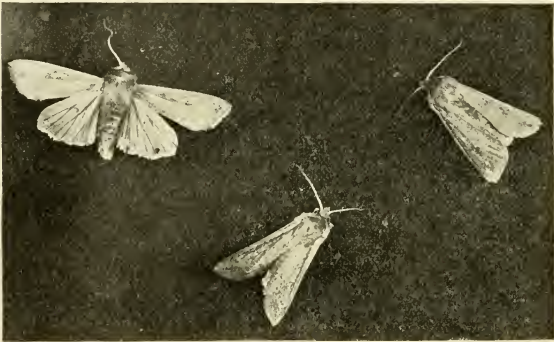


FIG. 4. Moths of Army Worm : natural size. (Original).

masses toward adjacent fields. "Their numbers at these times," wrote Dr. C. V. Riley, "are often so enormous, and their voracity so great, that it is impossible for one who has not been an eye witness to appreciate it fully. * * * The army worm when traveling will scarcely turn aside for anything but water, and even shallow water courses will not always check its progress, for the advance columns will often continue to rush headlong into the water until they have sufficiently choked it up with their dead and dying bodies to enable the rear guard to cross safely over. I have noticed that after crossing a bare field or bare road where they are subjected to the sun's rays, they would congregate in immense numbers under the first shade they reached. In one instance I recollect their collecting and covering the ground five or six deep all along the shady side of a fence for about a mile,

while scarcely one was seen to cross on the sunny side of the same fence." This avoidance of the sunshine must have been noticed by every observer of army worm outbreaks. On damp, cloudy days one may find numbers of them feeding near the top of grass and grain stalks, but on hot, sunny days few if any are to be found in such situations. They then occur in the shaded rubbish at the soil surface.

THE CHOICE OF FOOD

The army worm feeds by preference upon plants of the great grass family, which includes both the grasses and grains. The moths are especially attracted, for the deposit of their eggs, to rank growths of grass-like plants. To this is due the fact that in New Hampshire this year the brood of worms destructive in July was oftenest found in barley fields, while that destructive in September ravaged the fields of Hungarian grass. In feeding upon timothy and similar grasses the leaves are first stripped, and in cases of severe attacks the heads will be wholly or partially gnawed off; one such is represented in Fig. 5. They also feed freely upon the leaves and more or less upon the succulent stalks of wheat, oats, barley, rye, sorghum, and Indian corn. Generally they feed upon clover only when driven to it by hunger.

THREE BROODS IN NEW HAMPSHIRE

Apparently there were three broods of worms in New Hampshire this season. Before the destructive brood that appeared in July there must have been a brood developed during late spring or early summer. Some members of this generation, and perhaps most, probably passed the winter as par-

FIG. 5. Head of Timothy grass gnawed by army worms. (Original).



tially-grown worms, while others may have wintered over in other stages of the insects' existence, for the broods are by no means definitely limited. In a given field at a given time one may find many sizes of worms. The worms injurious in July were doubtless the second generation for the season. The majority of these entered the pupa state during the middle or latter part of the month and emerged as moths early in August. The first week in August, at Durham, the moths were extraordinarily abundant. The progeny of this brood of moths became full grown larvæ in September, changing to pupæ late in the month, and at this writing (October 19) a few of those in our breeding cages have come forth as moths. But I presume that out-of-doors more members of this brood may have matured by this time, and that larvæ from them will become partially grown before winter sets in. Yet it seems almost certain that many of the pupæ must go through the winter without changing to moths; and that many of the moths must hibernate without laying eggs.

THE LIFE-STAGES OF THE INSECT DESCRIBED

The egg of the army worm moth is a tiny whitish sphere with a diameter of only about one fiftieth of an inch. When first deposited it is dull and opaque, but soon afterward it becomes shiny and more or less iridescent. Just before hatching it appears much darker. The spherical outline in many specimens is changed by the sticky material attached to them at the time the eggs are deposited. Specimens, natural size and magnified, are represented in Fig. 6, *a*, *b*.

The larva when full-grown is of the form represented in Figures 3 and 6 *c*, and the lower illustration on the title page (for which I am indebted to the New York experiment station). It is a smooth, cutworm-like caterpillar, an inch and a half long, generally of a dark gray or dingy black color, "with three narrow yellowish stripes above, and a broader one or slightly darker on each side, thinly clothed with short hairs (to be seen with a lens) which are longer and somewhat thicker on and about the head. The latter is of a polished honey yellow color, with a network of fine dark brown lines and a black line on the

front like the letter V reversed." The size of the mature worms varies considerably, some specimens reaching a length of two inches.

The *Pupa* into which the full-grown army worm changes before it can become a moth is represented in Figure 6 *d*. It is a quiet, footless, wingless object, of a bright mahogany brown color, and measures about three-fourths of an inch in length. At the smaller end there are two pointed projections side by side, and near the base of each projection is a smaller, more slender spine with a hooked tip.

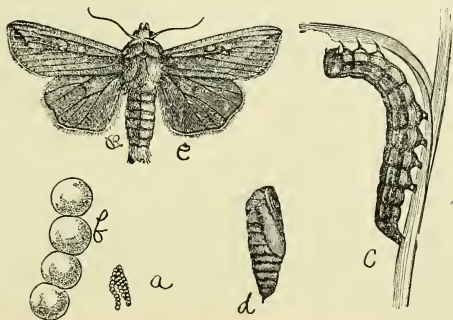


FIG. 6. The Army Worm : *a*, egg-mass, natural size ; *b*, eggs, magnified ; *c*, full-grown larva ; *d*, pupa ; *e*, moth. (After Riley).

The *adult moth* into which the army worm develops, and from the eggs of which it originates, is represented, natural size, in Figures 4 and 6 *e*. Its expanded wings measure about an inch and a half from tip to tip, although there is considerable variation in the size of different specimens. The general color of the body and front wings is a peculiar reddish-gray, perhaps more distinctly described as fawn color. Near the middle of each front wing are two more or less irregular lighter patches, each of which on closer study is seen to be made up of three smaller spots. Along the side margins of both pairs of wings there is a fringe of feathery scales, immediately inside of which, on each of the front wings, is a row of blackish dots. The hind wings are more grayish, with less of the reddish tinge.

THE ARMY WORM'S ENEMIES

Fortunately for the American farmer, the army worm has a host of natural enemies, which generally keep it below the danger line. A large number of birds consider the juicy worms excellent eating, and feed freely upon them. A list of such birds would include nearly all our native insectivorous species that search for food upon the ground, but special mention should be made of the robin, the blackbird, the bobolink, and the meadow lark, which search grass-lands for insect larvæ more persistently than many other of our common birds. These and other birds are very useful in keeping army worms and cutworms in check, and should be encouraged by every one.

But the birds are not the only enemies of the army worm. In the fields where the pest has been present this season there have also been found a great many large black beetles, some of them similar to the one represented in Fig. 7, and others somewhat larger. During July I examined a barley field in which



FIG. 7. Black Ground Beetle. (After Riley).

the grain had recently been cut and placed in piles, beneath which the army worms had congregated in great numbers. There were also present beneath each pile about a dozen of these black beetles, devouring the helpless worms. These predaceous beetles are commonly called ground beetles, because of their habit of living upon the ground, but sometimes they are also called caterpillar hunters.

There are also many species of internal parasites that prey upon the army worms. Among the most abundant of these are certain two-winged flies that glue eggs upon the backs of the worms. The eggs hatch into tiny footless maggots, that enter the bodies of the worms when they hatch, and develop inside at the expense of their unwilling hosts. Finally they kill the worms and the maggots change to pupæ, from which they soon emerge as flies. These are called *Tachina* flies.

There are several species of four-winged *Ichneumon* flies that have a similar history, and are often very destructive to the hosts of army worms.

The larger ground spiders also feed freely upon these worms; and the moths are often entrapped in the webs of the spinning spiders (Fig. 8).

More fateful and insidious even than these other enemies, are the microscopic germs of a bacterial disease—a sort of insect cholera—that often attacks the army worm when it becomes over-abundant, reducing quickly its invading ranks to below the normal level.



FIG. 8. Army Worm Moths entrapped in a Spider's Web. (Original).

To the action of these various natural checks is doubtless due the seemingly strange appearance and disappearance of this vexatious pest. Nature strives ever to keep a balance in her affairs, and when an insect becomes too abundant, she marshals her various forces to bring it into subjection.

REMEDIAL AND PREVENTIVE MEASURES •

When an outbreak of army worms is first noticed, if it is confined to a limited area it is generally well worth while to cut down the grass or grain infested. The worms will remain beneath its shelter for two or three days, and as soon as the cut grass or grain is dry enough it should be burned, thus destroying the pests and preventing the invasion of neighboring fields. The worms may also be destroyed by spraying them with strong

kerosene emulsion. This is prepared by adding 2 gallons of kerosene to 1 gallon of a solution made by dissolving $\frac{1}{2}$ pound of hard soap in 1 gallon of boiling water, and churning the mixture by forcing it back into the same vessel through a force-pump with a rather small nozzle, until the whole forms a creamy mass, which will thicken into a jelly-like substance on cooling. The soap solution should be hot when the kerosene is added, but of course must not be near a fire. The emulsion thus made is to be diluted before using against the army worm with five or six parts of water to one part of emulsion. The amount of dilution varies with different insects. Soft water or rain water should be used in diluting. If this cannot be obtained add a little lye or bicarbonate of soda. It should be applied with a spray pump or nozzle.

Trapping in Ditches and Trenches.—The device of stopping the armies of travelling worms by means of ditches and trenches occurred to the earliest sufferers from their depredations. In the New Hampshire outbreak of 1770, Mr. Powers tells us that the inhabitants “dug trenches around their fields a foot and a half deep, hoping this might prove a defense; but they soon filled the ditch, and the millions that were in the rear went over on the backs of their fellows in the trench and took possession of the interdicted food. The inhabitants then adopted another expedient to save those fields yet standing. They cut a trench as before; then took round and smooth sapling sticks, of six or eight inches diameter and six or eight feet in length, sharpened them to a point, and with these made holes in the bottom of the ditch, once in two or three feet; and as their meadows were bottom lands, they experienced no difficulty in extending these holes to two or three feet in depth below the bottom of the trench. The sides of these holes were made smooth by the bar or lever which made the holes, and as soon as the worm stepped from the precipice he ended at the bottom, and could not ascend again; indeed, he was soon buried by his unfortunate fellows who succeeded him in his downfall. Now those who made these holes to entrap their invaders went around their fields and plunged these pointed levers into the holes filled with worms, and destroyed every one of them at a single thrust.” Similar methods of fencing off the worms have often

been employed to good advantage since. The side of the furrow or trench next the field to be protected should incline obliquely so that the upper part will be nearer the side toward the worms than the lower part, thus rendering its ascent more difficult. In cases where holes are not dug in the bottom of the trench to trap the worms, they may be killed by dragging boards or small logs along, or by strewing the trench with straw from time to time and then burning it.

Fencing Out.—Some years ago Dr. C. V. Riley wrote: "From experiments which I have made, I am satisfied that where fence lumber can be easily obtained it may be used to advantage as a substitute for the ditch or trench by being secured on edge and then smeared with kerosene or coal tar (the latter being more particularly useful) along the upper edge. By means of laths and a few nails the boards may be so secured

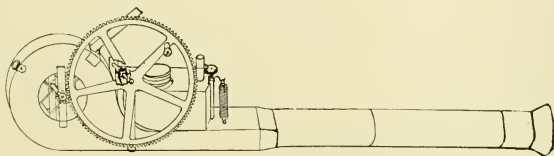


FIG. 9. Standard Paris Green Duster. (Original).

that they will slightly slope away from the field to be protected. Such a barrier will prove effectual where the worms are not too persistent or numerous. When they are excessively abundant they will need to be watched and occasionally dosed with kerosene to prevent their piling up even with the top of the board and thus bridging the barrier. The lumber is not injured for other purposes subsequently."

Poisoning.—One of the simplest ways of preventing injury by the army worm, where it can be done without danger to livestock, is that of dusting or spraying with poison a strip of grass or grain in advance of invaders. The simplest way of doing this would be to apply Paris green when the dew is on in the morning by means of one of the insecticide bellows now upon the market, designed more especially for use against the potato beetle. We have used two patterns of these this season.

and found them to do excellent service. One of these—the Standard Paris Green Duster—is shown diagrammatically in Fig. 9. It is an admirable machine, and will distribute a pound of Paris green evenly over an acre of potato vines. The other, called Leggett's Insect Powder Gun, is shown in Fig. 10. It is a slightly larger machine, costing also a little more, but it does excellent work. With either of these machines the poison can be applied much more easily than by any other method. The poison can be applied to a strip of grass by the spray-pump or nozzle, or even from a watering-pot, but this is an unsatisfactory way, because the grass-blades do not hold the spray. It would probably be better to dust the poison from the bags on the end of poles. Cattle should not be allowed in the field so treated until there has been plenty of time for the rains to wash the poison into the soil.

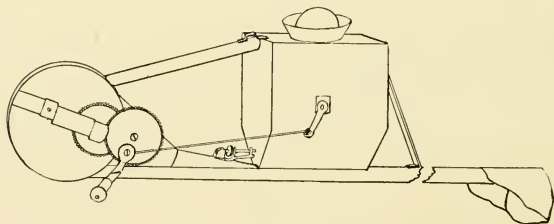


FIG. 10. Leggett's Insect Powder Gun. (Original).

Drawing the Rope.—One of the earliest devices resorted to for the prevention of injury to wheat by the army worm was that of “drawing the rope.” In his account of the attack of army worms in 1770, Mr. Powers writes that “two men would take a rope, one at each end, and pulling from each other until it was nearly straightened, they would pass through their wheat-fields and brush off the worms from the stalks and by perpetual action they retarded the destruction of their wheat; but it was doomed finally to destruction.” Of course this is a laborious and generally impracticable device, which might be used to advantage only under exceptional circumstances.

Burning Over Grasslands.—There is probably no general method that can be used more effectively for destroying army worms than that of burning over, in autumn or early spring, grasslands in which the worms are present. As already indicated, a portion of the pests appear to go through the winter as partly-grown worms. Consequently it seems well worth while to examine carefully fields in which they are likely to be present, and burn them over as thoroughly as is possible. Where it can easily be done, this burning is also advisable as a preventive measure, even in regions where the worm has not been destructive this year. The burning should also include old rubbish heaps and such worthless miscellaneous materials as may serve as a hiding-place for this and other injurious insects, either in the larval or moth states.

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